MULTIBEAM SCANNER

Japanese Unexamined Patent No. 2001-4941

Laid-open on: January 12, 2001

Application No. 2000-117359

Filed on: April 19, 2000

Inventor: Tomohiro NAKAJIMA

Applicant: Ricoh Co., Ltd.

SPECIFICATION

[TITLE OF THE INVENTION] MULTIBEAM SCANNER

[ABSTRACT]

[Theme] To provide a multibeam scanner which realizes low cost and excellent assembly performance by making multibeam scanning possible in a simple structure.

[Solution Means] The directions of emissions of a plurality of light beams B1 and B2 from a light source part 6 are set so as to intersect each other at a point P. In addition, by providing a light beam diameter regulating means 13 in the vicinity of the point P, the point P of intersection of the plurality of light beams B1 and B2 is set on the optical axis (rotation axis) C, this not only eliminates positional changes of the light beams B1 and B2 even when rotating the light source

part 6 in response to sub-scanning pitch adjustments but also makes it possible to form the light beams without tilting, whereby accuracy in arranging adjustments of semiconductor lasers 1 and 2 and coupling lenses 4 and 5 which are components of the light source part 6 can be relaxed.

[WHAT IS CLAIMED IS;]

[Claim 1] A multibeam scanner which comprises at least a light source part for emitting a plurality of light beams and a polarizing means for polarizing the light beams, and images light beams that have been polarized by the polarizing means on a scanning surface, wherein

setting is made so that the directions of emissions of the plurality of light beams from the light source part intersect each other.

[Claim 2] The multibeam scanner according to Claim 1, wherein setting is made so that the plurality of light beams emitted from the light source part intersect each other in the vicinity of the polarizing means.

[Claim 3] The multibeam scanner according to Claim 2, wherein a light beam diameter regulating means which shapes the beam diameters of the light beams emitted from the light source part into a predetermined diameter is provided in the vicinity of the point of intersection of the light beams..

[Claim 4] The multibeam scanner according to Claim 3, wherein setting is made so that the plurality of light beams emitted from the light source part intersect on a polarizing surface of the polarizing means.

[Claim 5] The multibeam scanner according to Claim 1, wherein a light beam diameter regulating means which shapes the beam diameters of the light beams emitted from the light source part into a predetermined diameter is provided in the vicinity of the point of intersection of the light beams.

[Claim 6] The multibeam scanner according to Claim 3 or 5, wherein the respective polarizing surfaces of the polarizing means compose the light beam diameter regulating means, and the diameters of the beams to enter the polarizing means are set to be larger than the polarizing surface diameter at least in the main-scanning direction.

[Claim 7] The multibeam scanner according to Claim 6, wherein each polarizing surface of the polarizing means is set to be smaller than the size of one side of the polarizing means.

[Claim 8] A multibeam scanner which comprises a light source part having a plurality of light sources and coupling lenses which convert light emitted from these light sources into light beams having predetermined convergence or divergence, a polarizing means for polarizing the light beams, and an imaging

means for imaging light beams polarized by the polarizing means on a scanning surface, wherein

setting is made so that the directions of emissions of the plurality of light beams from the light source part intersect each other.

[Claim 9] The multibeam scanner according to Claim 8, wherein setting is made so that the plurality of light beams emitted from the light source part intersect each other in the vicinity of the polarizing means.

[Claim 10] The multibeam scanner according to Claim 9, wherein a light beam diameter regulating means which shapes the diameters of the light beams emitted from the light source part into a predetermined diameter is provided in the vicinity of the point of intersection of the light beams.

[Claim 11] The multibeam scanner according to Claim 10, wherein setting is made so that the plurality of light beams emitted from the light source part intersect each other on a polarizing surface of the polarizing means.

[Claim 12] The multibeam scanner according to Claim 8, wherein a light beam diameter regulating means which shapes the diameters of the light beams emitted from the light source part into a predetermined diameter is provided in the vicinity of the point of intersection of the light beams.

[Claim 13] The multibeam scanner according to Claim 10 or 12, wherein the respective polarizing surfaces of the polarizing means compose the light beam diameter regulating means, and the diameters of the light beams to enter the polarizing means are set to be larger than the polarizing surface diameter at least in the main scanning direction.

[Claim 14] The multibeam scanner according to Claim 13, wherein each polarizing surface of the polarizing means is formed to be smaller than the size of one side of the polarizing means.

[Claim 15] A multibeam scanner which comprises a light source means that includes a semiconductor laser array having a plurality of emission sources monolithically formed and coupling lenses which convert light from this semiconductor laser array into light beams having predetermined convergence or divergence, a polarizing means for polarizing the light beams, and an imaging means for imaging light beams polarized and scanned by the polarizing means on a scanning surface, wherein the plurality of emission sources are arranged in the main scanning direction, and a converging means having converging action at least in the main scanning direction is provided.

[Claim 16] The multibeam scanner according to Claim 15, wherein a light beam diameter regulating means which shapes the diameters of light beams into a predetermined diameter is provided in

the vicinity of the point of intersection of the light beams.

[Claim 17] The multibeam scanner according to Claim 15, wherein the respective polarizing surfaces of the polarizing means compose the light beam diameter regulating means, and the diameters of the light beams to enter the polarizing means are set to be larger than the polarizing surface diameter at least in the main scanning direction.

[Claim 18] The multibeam scanner according to Claim 17, wherein each polarizing surface of the polarizing means is set to be smaller than the size of one side of the polarizing means.

[Claim 19] The multibeam scanner according to Claim 18, wherein coupling lenses are provided so that light from the light source means becomes divergent light beams.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Field of the Invention] The present invention relates to a multibeam scanner which is applied to optical scanning devices to be used in writing systems such as a digital copying machine and a laser printer, etc., and more specifically, a multibeam scanner which can improve the recording rate by simultaneous scanning of a scanning surface of a photoreceptor, etc., by a plurality of light beams.

[0002]

[Prior Arts] Conventionally, as a means for improving the recording rate in an optical scanning device to be used in such a type of writing system, a method for increasing the rotation speed of a polygon mirror that is a polarizing means exists. However, in this method, a load on the polygon motor increases, and its durability, noises, and vibrations come into question, and there is a limitation in the increase in rotation speed.

[0003] Therefore, a multibeam scanner which simultaneously records a plurality of lines simultaneously scanned by a plurality of laser beams has been suggested. As an example, as disclosed in Japanese Unexamined Patent Publication No. H06-331913, a method for synthesizing light beams from a light source means using a plurality of semiconductor lasers by a beam splitter exists. In the same publication, two light source units each of which comprises a semiconductor laser for emitting a single light beam, a coupling lens, and a coupling lens holding member are arranged so as to make incident light on a cubic beam splitter from orthogonal directions, whereby parallel light fluxes shaped by apertures are synthesized. The positions of the light beams in the sub-scanning direction are detected by sensors provided out of a recording region, and a relative angle between paired prisms that are disposed in the optical path of the beam splitter and the semiconductor lasers is changed

to correct the optical axes of the light beams. However, this method requires accurate control in optical axis accuracy of the beams, so that the adjusting mechanism becomes complicated and its adjusting operation is not easy.

[0004] Furthermore, a construction in which a plurality of semiconductor lasers or one semiconductor laser array is used to emit a plurality of light beams is illustrated in the following publications. For example, according to Japanese Patent Publication No. H6-94215, two light source units each of which comprises a semiconductor laser for emitting a single light beam, a coupling lens, and a coupling lens holding member are arranged so as to make incident light on a cubic beam splitter from orthogonal directions, whereby parallel light beams shaped by apertures are synthesized. According to Japanese Unexamined Patent Publication No. H10-243186, two light source units each of which comprises a semiconductor laser for emitting a single light beam, a coupling lens, and a coupling lens holding member are arranged so as to make incident light on a cubic beam splitter from orthogonal directions, and synthesized light beams are collimated into parallel light beams through a single coupling lens and then shaped by an aperture. According to Japanese Unexamined Patent Publication No. H10-213773, a semiconductor laser array having a plurality of emission sources

monolithically formed is arranged so that the emission sources are lined up in the sub-scanning direction, and light is collimated into parallel light beams. In this case, the light beams are made incident on a polygon mirror from the exit side of a scanning lens. The diameter of each light beam is set to be larger than the diameter of one surface of the polygon mirror so that an overfield optical system in which only a light component that has been reflected in response to rotation of the polygon mirror is scanned is composed.

[0005] On the other hand, a multibeam scanner using a new multibeam light source means having improved assembly performance by providing a plurality of semiconductor lasers and coupling lenses formed into a module and synthesizing, approximating, and emitting light beams of the lasers by a beam synthesizing means has been suggested. This realizes easy adjustment of sub-scanning pitches in a simple structure.

[0006]

[Problems to be Solved by the Invention] As mentioned above, in a method in which beam synthesization is carried out by using a beam splitter by providing two or more light source units using semiconductor lasers, there is a possibility that components such as an optical housing and light source units are deformed by environmental changes, posture changes of the

light source units themselves and arrangement errors of the semiconductor lasers and coupling lenses occur, and sub-scanning beam pitches easily change at a scanning surface. Therefore, it is necessary that a detecting mechanism for measuring sub-scanning pitches is provided, and a correcting mechanism for correcting the pitches based on the detection results is provided. Particularly, in the abovementioned Japanese Unexamined Patent Publication No. H06-331913, since feedback correction is carried out by maintaining correct directivity through fine-adjustments of optical axes for each beam by using a prism, the structure becomes complicated and requires high cost.

[0007] On the other hand, in the abovementioned suggested example of module formation, a plurality of semiconductor lasers and coupling lenses are integrally supported on the same base member and the respective light beams are emitted by being separated by a predetermined angle in the main scanning direction, whereby sub-scanning pitch adjustments are made possible by only rotation of the entire light source units, and this significantly improves assembly performance. Furthermore, a method in which the same effect can be obtained by arranging the semiconductor lasers in proximity to each other without use of a beam synthesizing means has also been suggested.

[0008] However, in all of these methods of suggested examples, since the beam exit position deviates from the optical axis (rotation axis), the beam exit point also changes in accordance with sub-scanning pitch adjustments, resulting in tilt beams. As a result, optical axis adjusting accuracy for suppressing the amount of rotation to be small is required in arranging adjustments of the semiconductor lasers and coupling lenses.

[0009] Therefore, an object of the invention is to provide a multibeam scanner which realizes low cost and excellent assembly performance by making multibeam scanning possible in a simple structure.

[0010] Furthermore, considering the problem that the polarizing means inevitably increases in size due to an increase in the diameter of light beams reflected by the polarizing surface in accordance with a reduction in size of the beam spot on an image plane to achieve high density and this obstructs high speed rotation of the polarizing means, another object of the invention is to provide a multibeam scanner which can increase the range in which high-speed and high-density recording can be applied without an increase in size of the polarizing means.

[0011]

[Means for Solving the Problems] The multibeam scanner of the invention according to Claim 1 comprises at least a light source

part for emitting a plurality of light beams and a polarizing means for polarizing the light beams, and images light beams that have been polarized by the polarizing means on a scanning surface, setting is made so that the directions of emissions of the plurality of light beams from the light source part intersect each other.

[0012] Therefore, since the directions of emissions of the plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source part in response to pitch adjustments, and light beams can be formed without tilting, so that accuracy in arranging adjustments of the light source part can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0013] The invention according to Claim 2 is characterized in that, in the multibeam scanner of the invention according to Claim 1, setting is made so that the plurality of light beams emitted from the light source part intersect each other in the vicinity of the polarizing means.

[0014] Therefore, if a plurality of light beams separate from each other on the polarizing surface of the polarizing means, it is required that each polarizing surface diameter is increased, however, by intersecting the beams in the vicinity of the

polarizing means, the polarizing surface diameter can be small, whereby a multibeam scanner which can realize a higher speed and a higher density can be provided.

[0015] The invention according to Claim 3 is characterized in that, in the multibeam scanner of the invention according to Claim 2, a light beam diameter regulating means which shapes the beam diameters of the light beams emitted from the light source part into a predetermined diameter is provided in the vicinity of the point of intersection of the light beams.

[0016] Therefore, since the directions of emissions of the plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source part in response to pitch adjustments, and a light beam diameter regulating means is provided in the vicinity of this point of intersection, so that the light beam diameters can be formed without tilting, and accuracy in arranging adjustments of the light source part can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0017] The invention according to Claim 4 is characterized in that, in the multibeam scanner of the invention according to Claim 3, setting is made so that the plurality of light beams emitted from the light source part intersect on a polarizing surface of the polarizing means.

[0018] Therefore, in realizing the invention of Claim 3, since setting is made so that the plurality of light beams intersect each other on the polarizing surface of the polarizing means, as a result, an overfield optical system which can commonly use the polarizing surfaces of the polarizing means as a light beam diameter regulating means can be achieved, whereby a construction that is efficient in further downsizing is achieved.

[0019] The invention according to Claim 5 is characterized in that, in the multibeam scanner of the invention according to Claim 1, a light beam diameter regulating means which shapes the beam diameters of the light beams emitted from the light source part into a predetermined diameter is provided in the vicinity of the point of intersection of the light beams.

[0020] Therefore, since the directions of emissions of the plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source part in response to pitch adjustments, and since a light beam diameter regulating means is provided in the vicinity of the point of intersection, the light beam diameters can be formed without tilting, and accuracy in arranging adjustments of the light source part can be relaxed, whereby a multibeam scanner which achieves low cost and high productivity can be provided.

[0021] The invention according to Claim 6 is characterized in that, in the multibeam scanner of the invention according to Claim 3 or 5, the respective polarizing surfaces of the polarizing means compose the light beam diameter regulating means, and the diameters of the beams to enter the polarizing means are set to be larger than the polarizing surface diameter at least in the main-scanning direction.

[0022] Therefore, in prior arts, since the light beam reflecting position is moved within one surface in accordance with rotation of the polarizing means, it is necessary that the polarizing surface is made larger in accordance with an increase in light beam diameter, however, by achieving an overfield optical system in which light beams the diameters of which are larger than the polarizing surface diameter are made incident on the polarizing means and by using each polarizing surface of the polarizing means as a light beam diameter regulating means, the polarizing surface diameter becomes equal to the effective light beam diameter, and therefore, the polarizing surface diameter can be small, the polarizing means can be downsized, the load on the motor for driving the polarizing means is reduced and this makes high-speed rotation possible, whereby a multibeam scanner which can realize a higher speed and a higher density can be provided.

[0023] The invention according to Claim 7 is characterized in that, in the multibeam scanner of the invention according to Claim 6, each polarizing surface of the polarizing means is set to be smaller than the size of one side of the polarizing means.

[0024] Therefore, since each polarizing surface is smaller than the size of one side of the polarizing means, surface accuracy can be prevented from deteriorating due to looseness of the end portions of the polarizing surfaces of the polarizing means and polarizing surface diameter differences caused by scattering in dividing angles of the polarizing surfaces and scattering in the distance from the rotation center can be suppressed, whereby a stable beam spot diameter can be obtained, image recording with high quality is realized, and the thickness of the polarizing means can be secured even when the beam diameter becomes smaller in the sub-scanning direction and this prevents rigidity from being lost.

[0025] The invention according to Claim 8 comprises a light source part having a plurality of light sources and coupling lenses which convert light emitted from these light sources into light beams having predetermined convergence or divergence, wherein a polarizing means for polarizing the light beams, and an imaging means for imaging light beams polarized by the

polarizing means on a scanning surface, setting is made so that the directions of emissions of the plurality of light beams from the light source part intersect each other.

[0026] Therefore, since the direction of emission of the plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source part in response to pitch adjustments, and the light beams can be formed without tilting, so that accuracy in arranging adjustments of the light source part can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0027] The invention according to Claim 9 is characterized in that, in the multibeam scanner of the invention according to Claim 8, setting is made so that the plurality of light beams emitted from the light source part intersect each other in the vicinity of the polarizing means.

[0028] Therefore, if the plurality of light beams are separated from each other on the polarizing surface of the polarizing means, it is required that the diameter of each polarizing surface is set to be large, however, the light beams are made to intersect each other in the vicinity of the polarizing means, whereby the diameter of each polarizing surface can be small, and the polarizing means can be downsized, high-speed rotation

becomes possible due to reduction in load on the motor for driving the polarizing means, whereby a multibeam scanner which can realize a higher speed and a higher density can be provided.

[0029] The invention according to Claim 10 is characterized in that, in the multibeam scanner of the invention according to Claim 9, a light beam diameter regulating means which shapes the diameters of the light beams emitted from the light source part into a predetermined diameter is provided in the vicinity of the point of intersection of the light beams.

[0030] Therefore, since the directions of emissions of the plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source part in response to pitch adjustment, and furthermore, since a light beam diameter regulating means is provided in the vicinity of the point of intersection, the light beam diameters can be formed without tilting, and accuracy in arranging adjustments of the light source part can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0031] The invention according to Claim 11 is characterized in that, in the multibeam scanner of the invention according to Claim 10, setting is made so that the plurality of light beams emitted from the light source part intersect each other

on a polarizing surface of the polarizing means.

[0032] Therefore, in realizing the invention according to Claim 10, since setting is made so that the plurality of light beams intersect each other on the polarizing surface of the polarizing means, as a result, it becomes possible to achieve an overfield optical system in which the polarizing surfaces of the polarizing means are commonly used as a light beam diameter regulating means, and this makes the construction efficient for further downsizing.

[0033] The invention according to Claim 12 is characterized in that, in the multibeam scanner according to Claim 8, a light beam diameter regulating means which shapes the diameters of the light beams emitted from the light source part into a predetermined diameter is provided in the vicinity of the point of intersection of the light beams.

[0034] Therefore, since the directions of emissions of the plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source part in response to pitch adjustments, and furthermore, since a light beam diameter regulating means is provided in the vicinity of the point of intersection, the light beam diameters can be formed without tilting, and accuracy in arranging adjustments of the light source part can be relaxed, whereby

a multibeam scanner which realizes low cost and high productivity can be provided.

[0035] The invention according to Claim 13 is characterized in that, in the multibeam scanner according to Claim 10 or 12, the respective polarizing surfaces of the polarizing means compose the light beam diameter regulating means, and the diameters of the light beams to enter the polarizing means are set to be larger than the polarizing surface diameter at least in the main scanning direction.

[0036] Therefore, in prior arts, since the light beam reflecting position is moved within one surface in accordance with rotation of the polarizing means, it is necessary that the polarizing surface is made larger in accordance with an increase in light beam diameter, however, by achieving an overfield optical system in which light beams the diameters of which are larger than the polarizing surface diameter are made incident on the polarizing means and by using each polarizing surface of the polarizing means as a light beam diameter regulating means, the polarizing surface diameter becomes equal to the effective light beam diameter, and therefore, the polarizing surface diameter can be small, the polarizing means can be downsized, the load on the motor for driving the polarizing means is reduced and this makes high-speed rotation possible, whereby a multibeam

scanner which can realize a higher speed and a higher density can be provided.

[0037] The invention according to Claim 14 is characterized in that, in the multibeam scanner according to Claim 13, each polarizing surface of the polarizing means is formed to be smaller than the size of one side of the polarizing means.

[0038] Therefore, since each polarizing surface is smaller than the size of one side of the polarizing means, surface accuracy can be prevented from deteriorating due to looseness of the end portions of the polarizing surfaces of the polarizing means and polarizing surface diameter differences caused by scattering in dividing angles of the polarizing surfaces and scattering in the distance from the rotation center can be suppressed, whereby a stable beam spot diameter is obtained, image recording with high quality is realized, and the thickness of the polarizing means can be secured even when the beam diameter becomes smaller in the sub-scanning direction and this prevents rigidity from being lost.

[0039] The multibeam scanner of the invention according to Claim 15 comprises a light source means that includes a semiconductor laser array having a plurality of emission sources monolithically formed and coupling lenses which convert light from this semiconductor laser array into light beams having

predetermined convergence or divergence, a polarizing means for polarizing the light beams, and an imaging means for imaging light beams polarized and scanned by the polarizing means on a scanning surface, wherein the plurality of emission sources are arranged in the main scanning direction, and a converging means having converging action at least in the main scanning direction is provided.

[0040] Therefore, since the directions of emissions of the plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source means in response to sub-scanning pitch adjustments, and furthermore, since the light beams can be formed without tilting, accuracy in arranging adjustments of the semiconductor laser array and coupling lenses can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0041] The multibeam scanner of the invention according to Claim 16 is characterized in that, in the multibeam scanner according to Claim 15, a light beam diameter regulating means which shapes the diameters of light beams into a predetermined diameter is provided in the vicinity of the point of intersection of the light beams.

[0042] Therefore, since the directions of emissions of the

plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source means in response to sub-scanning pitch adjustments, and furthermore, since a light beam diameter regulating means is provided in the vicinity of the point of intersection, the light beam diameters can be formed without tilting, and accuracy in arranging adjustments of the semiconductor laser array and coupling lenses can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0043] The invention according to Claim 17 is characterized in that, in the multibeam scanner according to Claim 15, the respective polarizing surfaces of the polarizing means compose the light beam diameter regulating means, and the diameters of the light beams to enter the polarizing means are set to be larger than the polarizing surface diameter at least in the main scanning direction.

[0044] Therefore, in prior arts, since the light beam reflecting position is moved within one surface in accordance with rotation of the polarizing means, it is necessary that the polarizing surface is made larger in accordance with an increase in light beam diameter, however, by achieving an overfield optical system in which light beams the diameters of which are larger than the polarizing surface diameter are made incident on the

polarizing means and by using each polarizing surface of the polarizing means as a light beam diameter regulating means, the polarizing surface diameter becomes equal to the effective light beam diameter, and therefore, the polarizing surface diameter can be small, the polarizing means can be downsized, the load on the motor for driving the polarizing means is reduced and this makes high-speed rotation possible, whereby a multibeam scanner which can realize a higher speed and a higher density can be provided.

[0045] The invention according to Claim 18 is characterized in that, in the multibeam scanner according to Claim 17, each polarizing surface of the polarizing means is set to be smaller than the side of one size of the polarizing means.

[0046] Therefore, since each polarizing surface of the polarizing means is smaller than the size of one side, surface accuracy can be prevented from deteriorating due to looseness of the end portions of the polarizing surfaces of the polarizing means and polarizing surface diameter differences caused by scattering in dividing angles of the polarizing surfaces and scattering in the distance from the rotation center can be suppressed, whereby a stable beam spot diameter can be obtained, image recording with high quality is realized, and the thickness of the polarizing means can be secured even when the beam diameter

becomes smaller in the sub-scanning direction and this prevents rigidity from being lost.

[0047] The invention according to Claim 19 is characterized in that, in the multibeam scanner according to Claim 18, coupling lenses are provided so that light from the light source means becomes divergent light beams.

[0048] Therefore, since the light beams from the light source means are made divergent, even when a surface tilt correcting optical system in which the polarizing surface of the polarizing means and the image plane becomes geometrically conjugate to each other is constructed, the waist position of the light beams in the sub-scanning direction can be shifted from above the polarizing surface, and the polarizing surface diameter is secured and the light beam diameter can be regulated with accuracy, so that a stable beam spot diameter is obtained, whereby image recording with high quality becomes possible.

[0049]

[Embodiments of the Invention] An embodiment of the invention will be described with reference to Fig. 1 through Figs. 5. Fig. 1 shows the construction of a light source part of a multibeam scanner using two multipurpose semiconductor lasers, and Fig. 2 shows a sectional view thereof in a main scanning direction Y.

[0050] In Fig. 1, the two semiconductor lasers 1 and 2 are press-fitted and supported into fitting holes 3a formed adjacent to each other at an 8mm interval (distance enabling parallel arrangement of coupling lenses) in the main scanning direction at the back side of an aluminum die-cast base member 3. The positions of the coupling lenses 4 and 5 in the X direction are adjusted so that light beams emitted from the semiconductor lasers 1 and 2 have predetermined divergence, and the positions in the X and Z directions are further adjusted so that predetermined directions of beam emissions are obtained, and they are fixed by filling a UV curing adhesive agent in the space between these and U-shaped supporting portions 3b that are paired with the semiconductor lasers 1 and 2. The main components including the semiconductor lasers 1 and 2, base member 3, and coupling lenses 4 and 5 comprise the light source part 6.

[0051] Herein, in the present embodiment, as shown in Fig. 2, the fitting holes 3a are formed to have predetermined angles, respectively, from a symmetry axis of the optical axis C in the main scanning direction, and the axes of the coupling lenses 4 and 5 are made to cross each other so as to obtain intersection at a predetermined point P.

[0052] Furthermore, in the present embodiment, the fitting holes

3a are formed to be tilted, however, it is also possible that the coupling lenses 4 and 5 are made eccentric to the axes of the semiconductor lasers 1 and 2 in place of tilting so as to obtain predetermined beam emission angles.

[0053] The base member 3 is fixed to a holding member 7 by screws 8 and positioned by engaging a cylindrical portion outer circumference 7a around the optical axis C as a center axis into a fitting hole 9a in the side wall 9 formed as an optical housing, pressed upon inserting a spring 10, and a ring-shaped presser member 11 is latched on the brim portions 7b and supported so as to come into contact with the side wall 9 by its pressing force. Furthermore, a lifted bent portion 10a of the spring 10 is engaged into a hole 11a in the presser member 11, an arm 10b at the opposite side is latched on a projection 9b of the side wall 9 to generate a clockwise twisting force, and a rotation stopper portion 7c formed on the holding member 7 is butted against an adjusting screw 12, whereby rotational adjustments around the optical axis by the adjusting screw 12 are made possible.

[0054] Two light beams B1 and B2 emitted from the light source part 6 thus formed are regulated and shaped into a predetermined light beam diameter by an aperture 13 that is a light beam diameter regulating means disposed at the point P of intersection of

these beams as shown in Fig. 3. It is preferable that the aperture 13 is disposed in the vicinity of a polygon mirror that is the polarizing means in the optical path reaching the polygon mirror from the light source part 6, and it is also possible that the aperture 13 is disposed above the reflecting surfaces of the polygon mirror.

[0055] Herein, the embodiment is described on the assumption that the light beams are made to intersect on a reflecting surface (polarizing surface) of the polygon mirror. Fig. 4 shows an example of the construction of the multibeam scanner using the light source part 6 that is constructed as shown in Fig. 1. In this embodiment, the position of intersection between the light beams B1 and B2 emitted from the respective semiconductor lasers 1 and 2 is set on a reflecting surface 14a of the polygon mirror 14, and the reflecting surface diameter of the polygon mirror 14 is set to be equal to the aperture diameter. Furthermore, in this embodiment, the number of the reflecting surfaces 14a of the polygon mirror 14 is set to 10.

[0056] In Fig. 4, the light beams B1 and B2 emitted through the coupling lenses 4 and 5 in the light source part 6 pass through the cylinder lens 15, and then are reflected by the mirror 16 and made incident on the front surface of the polygon mirror 14 diagonally upward. At this point, the light beams

B1 and B2 emitted from the light source part 6 are formed to be divergent light beams, whereby the beams B become larger than the reflecting surface diameter M of the polygon mirror 14 as shown in Fig. 5(a), and therefore, light beams B1′ and B2′ reflected by the polygon mirror 14 are shaped into a predetermined light beam diameter as shown in Fig. 5(b).

[0057] The respective light beams B1′ and B2′ pass through a scanning lens 17, a mirror 18, and a scanning lens 19 as imaging means and are imaged as beams B1″ and B2″ with predetermined spot diameters on a photoreceptor 20 which forms a scanning surface.. Furthermore, the scanning line interval (sub-scanning pitch) P between the beams B1″ and B2″ is adjusted to an adjacent pitch of the recording density by the rotation angle θ around the optical axis as mentioned above, and the beams are simultaneously scanned (see the extracted drawing in Fig. 4).

[0058] Furthermore, as shown in Figs. 6 which show a modified example, it is also possible that the size of the reflecting surface 14a of the polygon mirror 14 is formed to be smaller than the size of one side of each face of the mirror. In the illustrated example, the portions 14b other than the reflecting surfaces 14a are provided with steps by means of chamfering and formed to be rough surfaces with low reflectances. Other than this method, for example, it is also possible that masking

or deposition of only the reflecting surfaces are applied to form the reflecting surfaces.

[0059] A second embodiment of the invention is described with reference to Fig. 7. The same components as those in the first embodiment are shown by using the same symbols (same applies to subsequent embodiments). This embodiment shows an example of application to a multibeam scanner which uses a light source means 23 having a semiconductor laser array 22 including two emission sources 21a and 21b formed monolithically, and Fig. 7 shows a sectional view of the construction of the light source part of the multibeam scanner of this embodiment in the main scanning direction Y.

[0060] The semiconductor laser array 22 is press-fitted and supported into a fitting hole 24a which is formed in the back side of a aluminum die-cast base member 24 so that the emission sources 21a and 21b are arranged in the main scanning direction Y. The sizes of the emission sources 21a and 21b are set to approximately 100μm. The position of the coupling lens 25 in the X direction is adjusted so that the light beams emitted from the respective emission sources 21a and 21b become beams with predetermined divergence, and furthermore, the positions in the Y and Z directions are adjusted so that the emission sources 21a and 21b are disposed so as to be symmetric with

respect to the optical axis of the coupling lens 25, and the coupling lens 25 is fixed by filling a UV curing adhesive agent in the space between the coupling lens and the supporting portion 24b.

[0061] The light beams that have exited from the coupling lens 25 is made eccentric to the optical axis C, so that they cross each other at the focal point of the coupling lens 25 and then diverge, and furthermore, in this embodiment, they are set so as to re-cross each other by the converging lens 26 that is a converging means on the reflecting surface (polarizing surface) 27a of the polygon mirror 27 that is the polarizing means.

[0062] Also in this embodiment, as in the first embodiment, the light beam diameter at the position of re-intersection is set to be larger than the reflecting surface diameter of the polygon mirror 27 so that the reflected light beam has a predetermined beam diameter. Furthermore, the base member 24 is fixed to the holding member 28 by screws, and pitch adjustments are carried out by rotational adjustments around the optical axis, however, this holding member 28 is the same as the holding member 7 in the first embodiment, so description thereof is omitted.

[0063] A third embodiment of the invention is described with

reference to Fig. 8. As the first embodiment, the present embodiment shows an example of application to a multibeam scanner using two multipurpose semiconductor lasers as light sources, and Fig. 8 shows a sectional view of the light source part in the main scanning direction Y.

[0064] In comparison with the case of the first embodiment, as shown in the supplementary explanation of the first embodiment, fitting holes 3a for semiconductor lasers 1 and 2 are formed without tilting, and coupling lenses 4 and 5 are disposed eccentric to the optical axis C in the main scanning direction, whereby beams are emitted at predetermined angles. In the holding member 7, a beam synthesizing means 31 for synthesizing beams emitted from the semiconductor lasers 1 and 2 is provided.

[0065] This beam synthesizing means 31 is formed of a triangular prism 32 and a parallelogram prism 33 bonded together. Thereby, a beam emitted from the semiconductor laser 1 passes through the beam synthesizing means 31 and is reflected by an inclined plane 33a of the parallelogram prism 33, reflected by the bonded surface 32a of the triangular prism 32, and then made to exit along the beam emission direction of the semiconductor laser 1. The semiconductor lasers 1 and 2 are disposed so that the emitting positions thereof are arranged by being separated by a predetermined distance in the main scanning direction from

each other in a symmetric manner with respect to the optical axis C, and the directions of emission are set so as to intersect each other in the vicinity of the polygon mirror 14.

[0066] Furthermore, the base member 3 is fixed to the holding member 7 by screws 8, and pitch adjustments are carried out by rotational adjustments around the optical axis C, and this is the same as in the abovementioned embodiment, so that description thereof is omitted.

[0067] Furthermore, in this embodiment, the directions of emission are tilted so that the beams separate from each other at the points of emission of the semiconductor lasers and then gradually come close to each other, and the same effect can also be obtained by changing the directions of emission by providing a converging lens as described in the following fourth embodiment.

[0068] A fourth embodiment of the invention is described with reference to Fig. 9. The present embodiment shows an example of application to a multibeam scanner using two multipurpose semiconductor lasers as light sources as in the first and third embodiments, and Fig. 9 shows a sectional view of the light source part in the main scanning direction Y.

[0069] In the present embodiment, aluminum die-cast base members 41 and 42 are prepared for each of the semiconductor lasers

1 and 2, and are press-fitted and supported into fitting holes 41a and 42a formed in the respective base members 41 and 42. These base members 41 and 42 are supported on attaching surfaces 43a and 43b orthogonal to each other of the flange member 43 made from the same material as that of the base members. In the flange member 43, a cubic beam splitter 44 for synthesizing the respective beams emitted from the semiconductor lasers 1 and 2 in directions orthogonal to each other is provided.

[0070] Coupling lenses 4 and 5 for the respective semiconductor lasers 1 and 2 are bonded to the projecting supporting portions 43a and 43b upon adjusting the respective X positions thereof so that the beams emitted from the respective semiconductor lasers 1 and 2 become light beams with predetermined divergence, and on the other hand, the base members 41 and 42 are screw-fixed by adjusting the Y and Z positions thereof so as to obtain predetermined beam emission directions.

[0071] Herein, in the present embodiment, emission points of the semiconductor lasers 1 and 2 are set on the optical axes of the coupling lenses 4 and 5 and separated from each other by a predetermined distance in parallel to each other in the main scanning direction, and the emission directions of the beams are set so that the beams are made to temporarily intersect in the optical path between a front lens 45a and a rear lens

45b of the converging lens 45 as a converging means composed of two lenses, exit from the rear lens 45b, and then intersect again in the vicinity of the polygon mirror 14. The front lens 45a of the converging lens 45 is installed integrally with the flange member 43, and the rear lens 45b is held separately from the light source part.

[0072] The flange member 43 is fixed to the holding member 46 by screws and pitch adjustments are carried out by rotational adjustments around the optical axis, and description thereof is omitted herein since it is the same as in the abovementioned embodiment.

[0073] Furthermore, the semiconductor lasers 1 and 2 may be aligned so that the emission positions thereof are separated by a predetermined distance in the main scanning direction and symmetric to each other with respect to the optical axis C, and it is also possible that the beams are not made to intersect in the optical path between the front lens 45a and the rear lens 45b of the converging lens 45, but are made to temporarily intersect in the optical path between the coupling lenses 4 and 5 and the converging lens 45. Furthermore, the converging lens may be composed of one lens as in the case shown in Fig. 7 where a semiconductor laser array 22 is used.

[0074] Furthermore, as mentioned above, the beams may intersect

each other any number of times, and by providing an aperture at a position of intersection that is closest to the polygon mirror 14 in the optical path between the light source part 6 and the polygon mirror 14 (in the embodiment, on the reflecting surface 14a of the polygon mirror 14), the postures of the beams and their central positions are controlled by the single aperture, and this prevents deviations due to pitch adjustments.

[0075] Furthermore, in these third and fourth embodiments, since pitch adjustments are carried out by rotation of the light source part, the semiconductor lasers 1 and 2 and the beam synthesizing means 31 and 44 are integrally constructed as the light source part 6, however, the construction is not limited to this, and a construction in which one optical axis can be slightly tilted in the sub-scanning direction with respect to the other optical axis can be employed for pitch adjustments, and the same effect can be obtained by separately supporting the semiconductor lasers.

[0076] Furthermore, in any case, in synchronizing detection for detecting writing position timings for the respective beams, the beams pass through a single synchronizing detection sensor in time series, so that synchronizing detection signals can be individually obtained.

[0077] In all of the abovementioned embodiments, examples of

application in the case using two beams are described, however, as matter of course, the invention can also be applied to a case using three or more beams.

[0078]

[Effects of the Invention] According to the invention as set forth in Claim 1, since setting is made so that the directions of emissions of a plurality of light beams emitted from the light source part intersect each other, the light beam positions do not change even with rotation of the light source part in response to pitch adjustments, and the light beams can be formed without tilting, and furthermore, accuracy in arranging adjustments of the light source part can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0079] According to the invention as set forth in Claim 2, in the multibeam scanner of Claim 1, a plurality of light beams emitted from the light source part are set so as to intersect in the vicinity of the polarizing means, the diameter of each polarizing surface can be small, the polarizing means can be downsized, the load on the motor for driving the polarizing means is reduced and this makes high-speed rotation possible, whereby a multibeam scanner which realizes a higher speed and a higher density can be provided.

[0080] According to the invention as set forth in Claim 3, since the directions of emissions of a plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source part in response to pitch adjustments, and furthermore, a light beam diameter regulating means is provided in the vicinity of this point of intersection, so that the light beam diameters can be formed without tilting, and accuracy in arranging adjustments of the light source part can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0081] According to the invention as set forth in Claim 4, in realizing the invention of Claim 3, since setting is made so that a plurality of light beams intersect each other on a polarizing surface of the polarizing means, an overfield optical system in which the polarizing surfaces of the polarizing means are commonly used as a light beam diameter regulating means can be achieved accordingly, whereby a construction which is efficient for further downsizing can be provided.

[0082] According to the invention as set forth in Claim 5, since the directions of emissions of a plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source part in response to pitch adjustments, and furthermore, a light beam diameter regulating

means is provided in the vicinity of this point of intersection, so that the light beam diameters can be formed without tilting, and accuracy in arranging adjustments of the light source part can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0083] According to the invention as set forth in Claim 6, in the multibeam scanner of Claim 3 or 5, an overfield optical system in which light beams with diameters larger than the polarizing surface diameter are made incident on the polarizing means is constructed, and the polarizing surfaces of the polarizing means are commonly used as a light beam diameter regulating means, so that the polarizing surface diameter becomes equal to the effective light beam diameter, and therefore, the polarizing surface diameter can be small, the polarizing means can be downsized, the load on the motor for driving the polarizing means is reduced and this makes high-speed rotation possible, whereby a multibeam scanner which realizes a higher speed and a higher density can be provided.

[0084] According to the invention as set forth in Claim 7, in the multibeam scanner of Claim 6, since each polarizing surface of the polarizing means is smaller than the size of one side of the polarizing means, deterioration in surface accuracy due to looseness of the end portions of the polarizing surfaces

of the polarizing means can be prevented, and differences in polarizing surface diameter caused by scattering in dividing angles of the polarizing surfaces and scattering in the distance from the rotation center can be suppressed, so that a stable beam spot diameter can be obtained and image recording with high quality becomes possible, and the thickness of the polarizing means can be secured even when the light beam diameter becomes smaller in the sub-scanning direction and rigidity is prevented from being lost.

[0085] According to the invention as set forth in Claim 8, since setting is made so that the directions of emissions of a plurality of light beams from the light source part intersect each other, the light beam positions do not change even with rotation of the light source part in response to pitch adjustments, the light beams can be formed without tilting, and accuracy in arranging adjustments of the light source part can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0086] According to the invention as set forth in Claim 9, in the multibeam scanner of Claim 8, since setting is made so that a plurality of light beams emitted from the light source part intersect each other in the vicinity of the polarizing means, the diameter of each polarizing surface can be small, the

polarizing means can be downsized, the load on the motor for driving the polarizing means is reduced and this makes high-speed rotation possible, whereby a multibeam scanner which realizes a higher speed and a higher density can be provided.

[0087] According to the invention as set forth in Claim 10, since the directions of emissions of a plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source part in response to pitch adjustments, and furthermore, a light beam diameter regulating means is provided in the vicinity of this point of intersection, the light beam diameters can be formed without tilting, accuracy in arranging adjustments of the light source part can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0088] According to the invention as set forth in Claim 11, in realizing the invention of Claim 10, since setting is made so that a plurality of light beams intersect on the polarizing surface of the polarizing means, an overfield optical system in which the polarizing surfaces of the polarizing means are commonly used as a light beam diameter regulating means can be achieved, whereby a construction which is efficient for further downsizing can be provided.

[0089] According to the invention as set forth in Claim 12,

since the directions of emissions of a plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source part in response to pitch adjustments, and furthermore, a light beam diameter regulating means is provided in the vicinity of this point of intersection, so that the light beam diameters can be formed without tilting, and accuracy in arranging adjustments of the light source part can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0090] According to the invention as set forth in Claim 13, in the multibeam scanner of Claim 10 or 12, an overfield optical system in which light beams the diameters of which are larger than the polarizing surface diameter are made incident on the polarizing means is constructed and the respective polarizing surfaces of the polarizing means compose a light beam diameter regulating means, so that the polarizing surface diameter becomes equal to the effective light beam diameter, and therefore, the polarizing surface diameter can be small, the polarizing means can be downsized, the load on the motor for driving the polarizing means is reduced and this makes high-speed rotation possible, whereby a multibeam scanner which realizes a higher speed and a higher density can be provided.

[0091] According to the invention as set forth in Claim 14,

in the multibeam scanner of Claim 13, since each polarizing surface of the polarizing means is smaller than the size of one side of the polarizing means, deterioration in surface accuracy due to looseness of the polarizing surface end portions of the polarizing means can be prevented, polarizing surface diameter differences caused by scattering in dividing angles of the polarizing surfaces and scattering in the distance from the rotation center can be suppressed, so that a stable beam spot diameter is obtained and image recording with high quality becomes possible, the thickness of the polarizing means can be secured even when the light beam diameters become smaller in the sub-scanning direction, and rigidity is prevented from being lost.

[0092] According to the invention as set forth in Claim 15, since a plurality of emission sources are arranged in the main scanning direction in a semiconductor laser array and a converging means having converging action at least in the main scanning direction is provided, the directions of emissions of a plurality of light beams intersect each other, and therefore, the light beam positions do not change even with rotation of the light source means in response to sub-scanning pitch adjustments, the light beams can be formed without tilting, and accuracy in arranging adjustments of the semiconductor laser

array and the coupling lens can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0093] According to the invention as set forth in Claim 16, since the directions of emissions of a plurality of light beams intersect each other, the light beam positions do not change even with rotation of the light source means in response to sub-scanning pitch adjustments, and furthermore, a light beam diameter regulating means is provided in the vicinity of this point of intersection, so that the light beam diameters can be formed without tilting, and accuracy in arranging adjustments of the semiconductor laser array and the coupling lens can be relaxed, whereby a multibeam scanner which realizes low cost and high productivity can be provided.

[0094] According to the invention as set forth in Claim 17, in the multibeam scanner of Claim 15, an overfield optical system in which light beams the diameters of which are larger than the polarizing surface diameter are made incident on the polarizing means is constructed and the respective polarizing surfaces of the polarizing means compose a light beam diameter regulating means, so that the polarizing surface diameter becomes equal to the effective light beam diameter, and therefore, the polarizing surface diameter can be small, the polarizing

means can be downsized, and the load on the motor for driving the polarizing means is reduced and this makes high-speed rotation possible, whereby a multibeam scanner which realizes a higher speed and a higher density can be provided.

[0095] According to the invention as set forth in Claim 18, in the multibeam scanner of Claim 17, since each polarizing surface of the polarizing means is smaller than the size of one side of the polarizing means, deterioration in surface accuracy due to looseness of the polarizing surface end portions of the polarizing means can be prevented and polarizing surface diameter differences caused by scattering in dividing angles of the polarizing surfaces and scattering in the distance from the rotation center can be suppressed, whereby a stable beam spot diameter is obtained and image recording with high quality becomes possible, and the thickness of the polarizing means can be secured even when the light beam diameter becomes smaller in the sub-scanning direction, so that rigidity is prevented from being lost.

[0096] According to the invention as set forth in Claim 19, in the multibeam scanner of Claim 18, since the light beams from the light source means are made divergent, even when a surface tilt correcting optical system in which the polarizing surface of the polarizing means and the image plane becomes

geometrically conjugate to each other is constructed, the waist position of the light beams in the sub-scanning direction can be shifted from above the polarizing surface, and the polarizing surface diameter is secured and the light beam diameter can be regulated with accuracy, so that a stable beam spot diameter is obtained, whereby image recording with high quality becomes possible.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1] An exploded perspective view of the light source means showing the first embodiment of the invention.

[Fig. 2] A sectional view of the same in the main scanning direction.

[Fig. 3] A perspective view showing light beam shaping by the aperture.

[Fig. 4] A perspective view showing an example of the entire construction of the multibeam scanner.

[Figs. 5] Perspective views for explaining the condition of the reflecting surfaces of the polygon mirror in the case where the reflecting surfaces are used as a light beam diameter regulating means.

[Figs. 6] Perspective views showing a modified example of the same.

[Fig. 7] A sectional view in the main scanning direction of

the light source means showing the second embodiment of the invention.

[Fig. 8] A sectional view in the main scanning direction of the light source part showing the third embodiment of the invention.

[Fig. 9] A sectional view in the main scanning direction of the light source part showing the fourth embodiment of the invention.

[Description of Symbols]

1, 2 light source

4, 5 coupling lens

6 light source part

13 light beam diameter regulating means

14 polarizing means

14a polarizing surface, light beam diameter regulating means

17, 19 imaging means

20 scanning surface

21a, 21b emission source

22 semiconductor laser array

23. light source means

25 coupling lens

26 converging means

27 polarizing means

27a polarizing surface

45 converging means

Fig.1

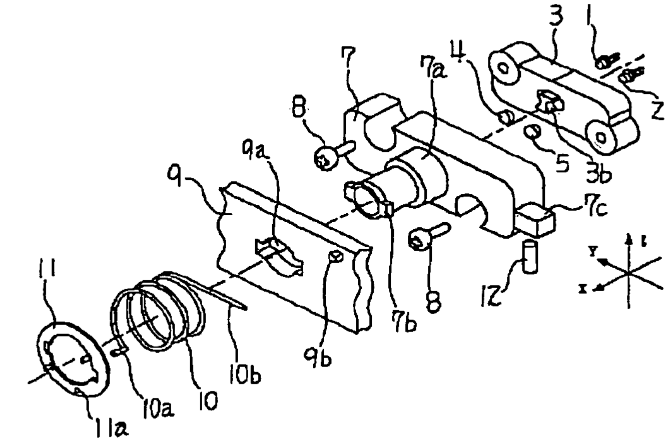

Fig.2

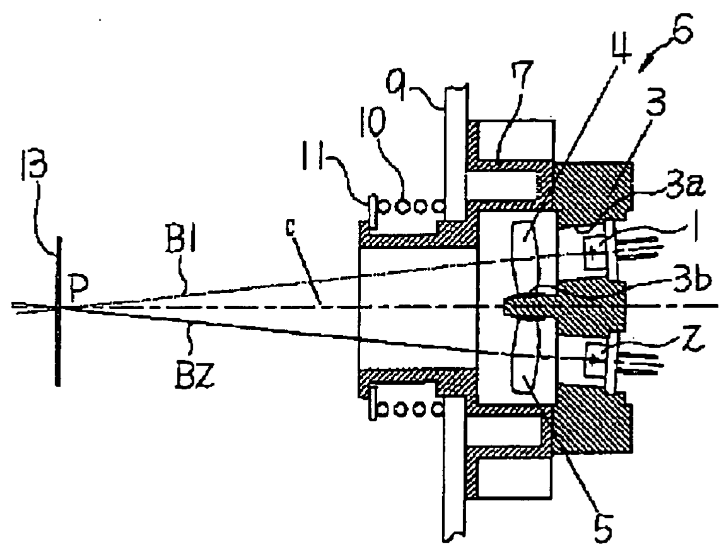

Fig.3

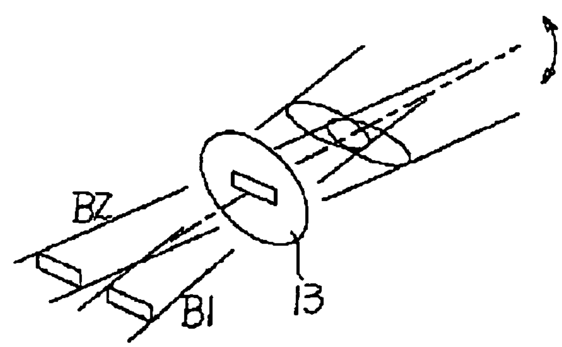

Fig.4

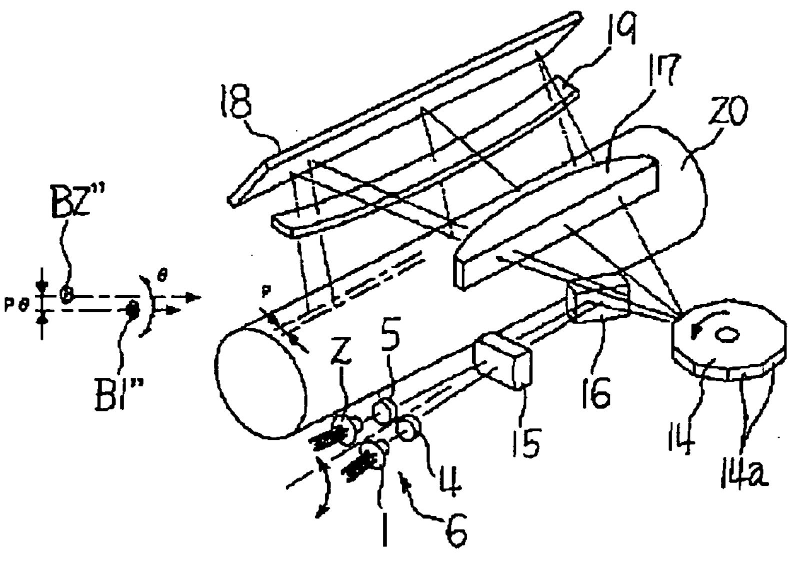

Fig.5

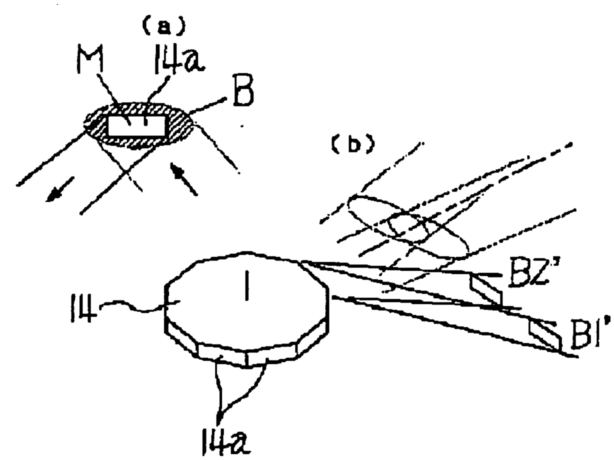

Fig.6

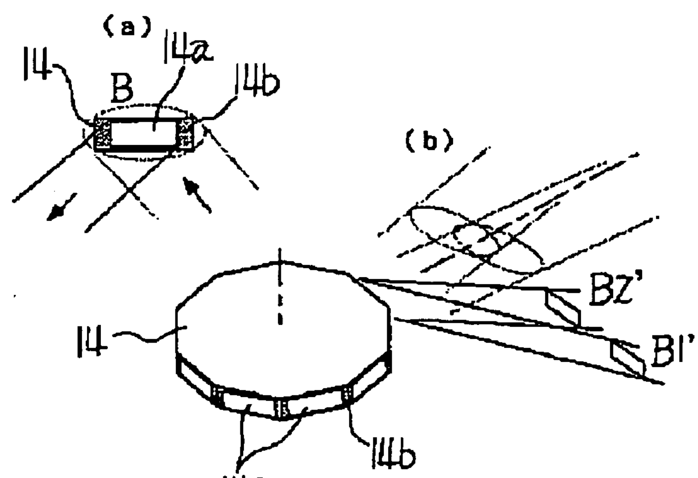

Fig.7

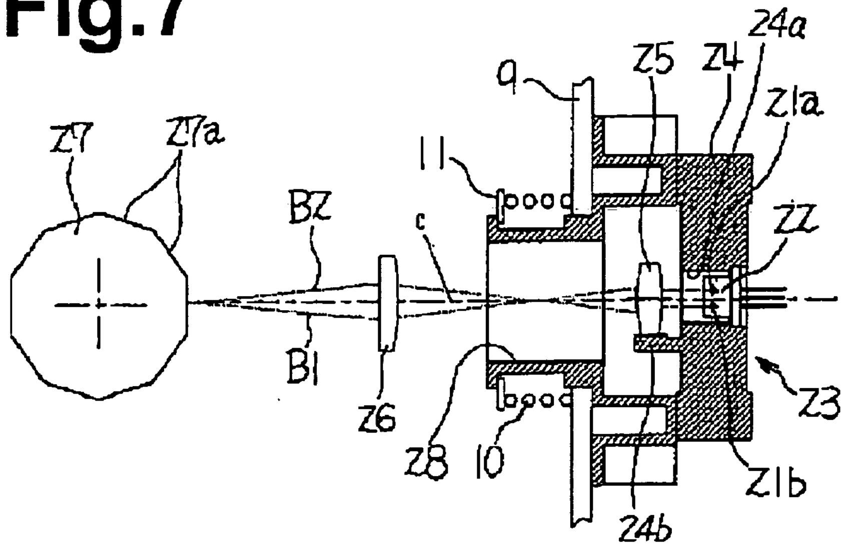

Fig.8

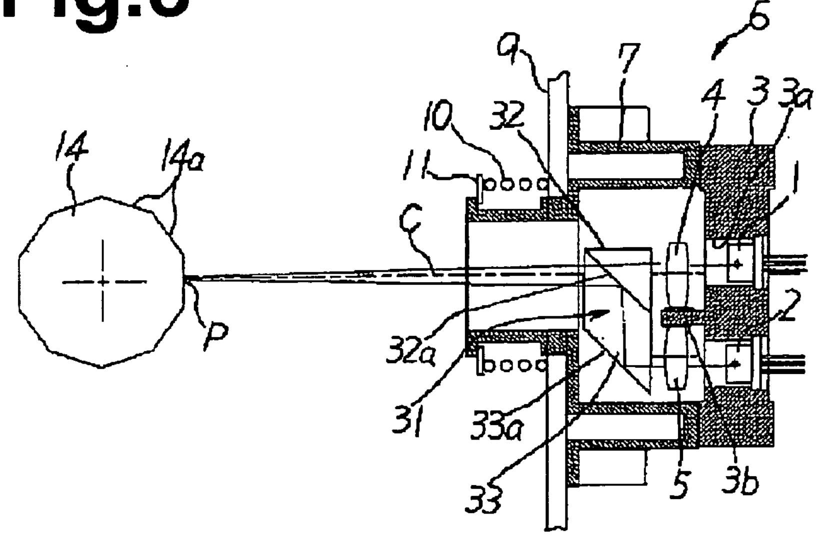

Fig.9